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RESULTS OF RESEARCH IN FOUR TOPIC AREAS: THE
SINGULARITY EXPANSION METHOD. (U) MISSISSIPPI UNIV
UNIVERSITY DEPT OF ELECTRICAL ENGINEERING
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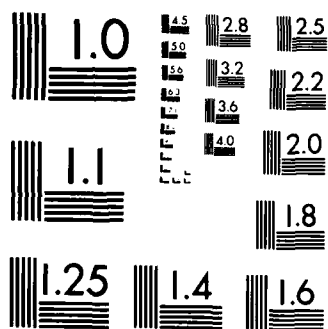
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report briefly presents the results of research in four topic areas investigated during the grant period. These four topic areas are: the Singularity Expansion Method, transient scattering measurements, high frequency diffraction at edges residing on interfaces, and cylindrical coordinate representation of dyadic Green's functions.		

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**FINAL REPORT
ONR CONTRACT N00014-81-K-0256
WITH THE
DEPARTMENT OF ELECTRICAL ENGINEERING
OF THE
UNIVERSITY OF MISSISSIPPI**

August, 1985

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This report provides a brief summary of the technical accomplishments associated with Office of Naval Research Contract Number N00014-81-K-0256. The publications and presentations produced through the activities of this contract are listed at the end of this report and are numbered sequentially. The text refers to these publications by number.

The activities on this contract may be grouped into four topic areas: the Singularity Expansion Method, transient scattering measurements, high-frequency diffraction at edges residing on interfaces, and cylindrical coordinate representation of dyadic Green's functions. Each of these topics is discussed in subsequent paragraphs.

The work accomplished in the area of the Singularity Expansion Method has focused on the questions of what constitutes a complete Singularity Expansion of a given field quantity and how one may determine the expansion quantities for complicated objects. Publication numbers 1,2,4, and 5 deal with the matter of the construction of a complete expansion. Numbers 2 and 5 deal, respectively, with the representation of surface current and of scattered fields for finite extent scatterers. The latter work identifies a component of the scattered field that cannot be represented as a resonant series--a conclusion corroborated by other workers. This result is significant in that the non-resonant part appears to carry the dominant energy content of the scattered field and raises a question as to the viability

of target identification/classification schemes based on resonance data. The book chapter, Ref. 1, is a summary work on the Singularity Expansion and highlights the significant features on the expansion that have been revealed through activities supported in part by this contract. This material has been communicated by a number of presentations and reports as well. (Pubs. 9, 14, 15, 21, and 27.)

Experimental activities have focused on the experimental extraction of Singularity Expansion quantities. The originally envisioned goal of determining SEM expansion parameters has been elusive, due to limitations in the capabilities of the signal processing methods that must be applied. One result of the experimental activities may prove useful apart from the SEM applications that originally motivated it. That is the development of an optically coupled sampling oscilloscope system. The most recent design of this system takes the form of a simple modification of a Tektronix S-6 sampling head in that the signals communicating between the head and the companion Tektronix 7S12 sampling plug-in are transmitted over fiber optic cables. The first design of this system was conducted in collaboration with the University of Kentucky with subcontracted ONR funds (Pubs. 10 and 18). A second prototype has been completed recently at the University of Mississippi, the development of which was partially supported with University funds. It is reported in Pubs. 8, 12, and 26. The last of these is a journal submission, which is being transmitted to the journal at the time of this writing.

The work associated with high frequency diffraction at edges residing on interfaces has been reported in two journal papers (Pubs. 6 and 7), and a number of conference presentations (Pubs. 16, 19, 20, 23, 24, and 25). Publications 11 and 13 are reports dealing with this

subject area. Two specific geometric configurations are treated in these publications. The first is that of a perfectly conducting half-plane residing on the interface between two half spaces with dissimilar electrical properties. The regions must be homogeneous and isotropic, but magnetic contrast and conductivity losses are allowed. The approach of Pubs. 6 and 11 provides, for the first time, a practical computational approach to the Wiener-Hopf factorization that arises in the exact formulation of this problem. The second geometry, that of a half-plane residing on one face of a dielectric slab, is treated so as to provide a more efficient numerical computation of the Wiener-Hopf factorization than previously available. Asymptotic evaluations of the fields for observation points distant from the edge were carried out, thereby demonstrating the feasibility of incorporating this class of geometries into the format of the geometrical theory of diffraction, through the use of numerically derived diffraction coefficients.

The fourth problem area treated under this contract is the expansion of dyadic Green's functions in cylindrical coordinate Hansen vector wave functions. Publication 3 identifies a pole term in the cylindrical expansion, similar to one in the spherical expansion identified previously by Collin, that is a contributor to the source-region (quasi-electrostatic) field. The conference presentation, Pub. 22, addressed the issue of dyadic expansion of the magnetic vector potential with numerical applications in mind.

PUBLICATIONS

BOOK CHAPTER

1. L. W. Pearson, "The Singularity Expansion Representation of Surface Current on a Perfectly Conducting Scatterer," in Hybrid Formulation of Wave Propagation and Scattering, L. B. Felsen, editor, The Hague, Martinus Nijhoff, 1984.

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2. L. W. Pearson, D. R. Wilton and R. Mittra, "Some Implications of the Laplace Transform Inversion on SEM Coupling Coefficients in the Time Domain," Electromagnetics, vol. 2, no. 3, July-September 1982, pp 181-200.
3. L. W. Pearson, "On the Spectral Expansion of the Electric and Magnetic Dyadic Green's Functions in Cylindrical Harmonics," Radio Science, vol. 18, no. 2, March-April, 1983, pp. 166-174.
4. L. W. Pearson, "Present Thinking on the Use of the Singularity Expansion in Electromagnetic Scattering Computation," Wave Motion, vol. 5, no. 4, June-August, 1983. INVITED PAPER
5. L. W. Pearson, "A Note on the Representation of Scattered Fields as a Singularity Expansion," IEEE Trans. Ant. and Propag., vol. AP-32, no. 5, May, 1984, pp. 520-529.
6. R. D. Coblin and L. W. Pearson, "A Geometrical Theory of Diffraction for a Half Plane Residing on the Interface Between Dissimilar Media: TM-Polarized Case," Radio Science, vol. 19, no. 5, Sept.-Oct., 1984, pp. 1277-1288.
7. L. W. Pearson and A. W. Glisson, "Diffraction of a Plane Wave at a Common Corner of P.E.C. and Penetrable Quarter Spaces," to be submitted to Radio Science.
8. S. B. Samaan, L. W. Pearson, and C. E. Smith, "An Optically-Coupled Sampling System with 4 GHz. Bandwidth," submitted to IEEE Trans. Instr. and Meas.
9. R. K. Naishadham and L. W. Pearson, "Numerical Evaluation of Complex Natural Resonances of an Elliptic Cylinder," to be published in IEEE Trans. Ant. and Propag.

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10. S. A. Dyer, R. L. Holbrook and L. W. Pearson, "An Optically Coupled Sampling System for Transient Electromagnetic Measurements," University of Kentucky Electromagnetics Research Report 82-3, December, 1982.

11. R. D. Coblin and L. W. Pearson, "Diffraction of an Electromagnetic Plane Wave from a Perfectly Electrically Conducting Half-Plane in the Proximity of Planar Media Discontinuities," University of Mississippi Report, February, 1983 (adapted from Ph.D. Thesis).
12. S. B. Samaan, L. W. Pearson, and C. E. Smith, "An Optically Coupled Sampling System with 4 GHz Bandwidth," University of Mississippi Report (Contract N00014-81-K-0256 to ONR), October, 1984. (adapted from M. S. Thesis).
13. T. H. Farris and L. W. Pearson, "Guided-Mode Launching in a Slab Waveguide by way of Diffraction at the Edge of a Perfectly Conducting Screen Residing on One Surface of the Slab," University of Mississippi Report (Contract N00014-81-K-0256 to ONR), May, 1985, (adapted from M. S. Thesis)

CONFERENCE AND SYMPOSIUM PRESENTATIONS

14. L. W. Pearson, "State of the Art of the Singularity Expansion Method," XXth Triennial General Assembly of the International Union of Radio Science, Washington, D. C., August, 1981, INVITED PAPER.
15. L. W. Pearson, "Complex Resonance Representation in Electromagnetic Scattering--Physical and Biological Applications," Mississippi Academy of Sciences 1982 Meeting, Biloxi, Mississippi, March 1982, INVITED PLENARY PRESENTATION.
16. R. D. Coblin and L. W. Pearson, "Diffraction by a Perfectly Conducting Half-Plane on a Dielectric Interface," National Radio Science Meeting, University of New Mexico, Albuquerque, New Mexico, May, 1982, with R. D. Coblin.
17. L. W. Pearson, "On the Computation of Dyadic Green's Functions in Terms of Cylindrical Vector Wave Functions," National Radio Science Meeting, University of New Mexico, Albuquerque, New Mexico, May, 1982.
18. S. A. Dyer, R. L. Holbrook, and L. W. Pearson, "Experimental Methods for Obtaining the Singularity Expansion Parameters for a Conducting Scatterer," National Radio Science Meeting, University of Colorado, Boulder, Colorado, January, 1983.
19. R. D. Coblin and L. W. Pearson, "Diffraction by a Perfectly Conducting Half-Plane Residing on a Dielectric Slab," National Radio Science Meeting, University of Houston, Houston, Texas, May, 1983.
20. R. D. Coblin and L. W. Pearson, "Asymptotic Evaluation of Fields Diffracted by a Conducting Half-Plane Residing on an Interface," 1983 URSI International Symposium on Electromagnetic Wave Theory, Santiago de Compostela, Spain, August, 1983.

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23. L. W. Pearson and T. H. Farris, "Guided-Mode Launching in a Slab Waveguide by way of Diffraction at the Edge of a Conducting Screen Residing on one Surface of the Slab," National Radio Science Meeting, Boston, Massachusetts, June, 1984.
24. L. W. Pearson and R. D. Coblin, "High Frequency Diffraction at Metallic Edges Near Media Interfaces," XXI General Assembly of the International Union for Radio Science, Florence, Italy, August, 1984, INVITED PRESENTATION.
25. L. W. Pearson and A. W. Glisson, "Diffraction of a Plane Wave at a Corner Common to P. E. C. and Penetrable Quarter Spaces," North American Radio Science Meeting, Vancouver, British Columbia, June, 1985.
26. S. B. Samaan, L. W. Pearson, and C. E. Smith, "An Optically Coupled Sampling System with 4 GHz Bandwidth," North American Radio Science Meeting, Vancouver, British Columbia, June, 1985.
27. R. K. Naishadham and L. W. Pearson, "Numerical Evaluation of Complex Resonances of an Elliptic Cylinder," North American Radio Science Meeting, Vancouver, British Columbia, June, 1985.

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